

### **REMARKS/ARGUMENTS**

Reconsideration is respectfully requested of the Office Action of May 30, 2007.

The rejection of Claims 1-6 under 35 U.S.C. § 103(a) as unpatentable over the *Nunan* paper is traversed and reconsideration is respectfully requested.

Although the Office Action of May 30, 2007 alleges that the SAE *Nunan* paper renders the presently claimed subject matter obvious to one of ordinary skill in the art, this paper in fact supports the claims in the current application. The paper shows that under the conventional preparation conditions described for a TWC (three-way catalyst) washcoat, alloying between Pd and Rh or Pt and Rh is expected and observed. See Introduction on page 1 of the paper. Extensive performance data in support of alloy formation is presented in the SAE *Nunan* paper. In particular, data shows that when alloying occurs between Pt-Rh there is little negative impact on the performance of the catalyst. This is well known in the scientific literature as the surface of Pt-Rh alloy crystallites are enriched in Rh. The performance of aged Pt-Rh catalysts is dominated by the Rh function. As a result alloying for Pt and Rh has little or no impact on performance with the exception of a small impact on hard HC oxidation, see Figures 1, 2 and 3 of the paper.

**This is not true for Pd-Rh alloy formation.** When Pd and Rh are added to the wash coat (WC) together and exposed to normal TWC aging conditions extensive alloy formation occurs. Pd-Rh alloy crystallite surfaces **are enriched in Pd**, thus hiding the Rh and suppressing performance functions associated with Rh. The dominant performance function associated with Pd is HC oxidation while **Rh is critical for NOx conversion.** Thus, alloying of Pd and Rh is characterized by a dramatic loss of the Rh function (loss of NOx conversion activity and also CO

performance) when both metals are present together in the support. As a result, in conventional TWC catalysts special measures are taken to separate Pd and Rh physically. Evidence for alloy formation between Pd and Rh is clearly shown in Figures 4 (CO) and 5 (NO<sub>x</sub>) of the 1995 SAE Nunan paper. This evidence is easily derived from the performance features of the Pd-Rh catalysts when both metals are in the WC together. Figures 4 and 5 (see page 4) show that when Pd and Rh are in the WC together a dramatic decrease is obtained in CO and NO<sub>x</sub> conversion, respectively. Further, if some pretreatments of the catalyst are carried out to de-alloy the Pd-Rh (separation of the metals) some recovery of the NO<sub>x</sub> performance is clearly seen. This can be achieved by high temperature treatment under oxidizing (lean) conditions. The recovery of NO<sub>x</sub> performance is shown in Figure 7 of the paper after lean pretreatment at an A/F = 14.9 at 900°C for 1 hour.

In conventional TWC catalyst designs the Pd and Rh are invariably kept apart either by layering (Pd located in one layer and Rh in the other layer) or by separation within the same WC or layer through pre-impregnation or selective platinum group metal (PGM) placement. In fact this is described in the US 6,335,305 patent by Suzuki *et al.* (of record). Separation of the metals is implied by Suzuki *et al.* in his Claim 12 where Suzuki states "The Catalysts of Claim 1, wherein Pd is loaded on the composite oxide; and at least one of Pt and Rh is loaded on the support". Thus, Suzuki recognizes that Pd and Rh need to be kept physically separate as is the conventional design strategy for Pd-Rh TWC catalysts.

In contrast to what is shown in the SAE Nunan paper, attention is invited to the Figures 7 and 8 which accompany this application which show different peaks for the presence of palladium and rhodium to form a non-alloyed, one-layer catalyst. If an alloy were to be formed,

there would not be two different peaks. Different peaks shown in the x-ray defraction patterns represented by Figures 7 and 8 demonstrate that the one-layer catalyst of this invention is essentially non-alloyed.

The SAE *Nunan* paper does not disclose a one-layer formulation of catalyst wherein 70% or more of the first catalyst and the second catalyst are non-alloyed under alloying conditions. Consequently, the SAE *Nunan* paper fails to disclose an essential feature of the present invention.

Neither is there any suggestion or teaching in the SAE *Nunan* paper which would provide a reason for a person skilled in the art to arrive at applicant's invention of a one-layer catalyst where at least 70% or more of the first and second catalyst are non-alloyed.

Accordingly, applicant respectfully submits that the SAE *Nunan* paper fails to create *prima facie* obviousness for the claimed invention and, therefore, the rejection should be withdrawn.

The rejection of Claims 7-10 under 35 U.S.C. § 103(a) as unpatentable over the *Nunan* article in view of *Fujitani, et al.*, US 4,239,656, (*Fujitani*) is traversed and reconsideration is respectfully requested.

The *Nunan* article has already been discussed above and fails to show an important feature of the present invention; namely, that the one-layer catalyst has 70% or more of the first catalyst metal and the second catalyst metal present in a non-alloyed condition.

*Fujitani* shows a variety of catalysts and also discloses the gamma alumina catalyst support. However, even if the catalyst support of *Fujitani* were used in the *Nunan* formulation, the combination would still not arrive at the subject matter of Claims 7-10.

More particularly, *Fujitani* does not render the present invention obvious for the following reasons:

- i) The particle size and pore size distribution (0.01– 2 microns) described by *Fujitani* covers an extremely wide range of pore sizes and in fact encompasses nearly all practical support materials commonly used in heterogeneous catalysis.
- ii) The reason *Fujitani* concerns himself with a discussion of porosity in this very wide range is that he is preparing  $\text{MgAl}_2\text{O}_4$  spinel materials by calcining a mixture of alumina and magnesia at up to  $1350^\circ\text{C}$ . Calcination at such high temperatures typically generates fully dense, low surface area materials as seen in Tables 4 and 6 of *Fujitani*.
- iii) The official action makes reference to *Fujitani* at col. 10, lines 65–68, where there is a disclosure of an alumina-magnesia support ( shown in table 5, in col.9) which *Fujitani* identifies as the C2 support material having a pore volume of  $0.5 \text{ cm}^3/\text{g}$ , a pore diameter of 0.02 microns and a surface area of  $98 \text{ m}^2/\text{g}$ . However, carrier 2 is a comparative carrier which is NOT in fact a part of the *Fujitani* invention. This is specifically stated later in col. 11, lines 21–25, where it is stated that the C2 support material is in fact not of the invention being described by *Fujitani*. Thus *Fujitani* states in col. 11, lines 21 - 25: "It is also evident that the catalysts (S3 and S4) having the carrier (No. C2) prepared by depositing ceria on the conventional carrier have much lower activities than the catalysts of the present invention." *Fujitani* clearly teaches away from using carriers of the type shown in his comparative carrier examples in Table 9.
- iv) In conclusion, the basis of the *Fujitani* invention is that the support for the PGMs (Pt, Pd and Rh) consists of a low surface area composite material consisting of  $\text{MgAl}_2\text{O}_4$  spinels,

alumina and ceria and that the catalyst preparation involves the physical separation of Pd and Rh in the formation of the final catalyst.

Accordingly, applicants respectfully submit that the combination of *Nunan* with *Fujitani* fails to create *prima facie* obviousness for the subject matter of Claims 7-10. Applicants therefore respectfully request that the rejection be withdrawn.

The rejection of Claims 11 and 12 under 35 U.S.C. § 103(a) as unpatentable over the *Nunan* article when taken with the *Fujitani* patent '656 and further in view of *Anatoly, et al.*, US 6,387,338, is traversed and reconsideration is respectfully requested.

The rejection of Claim 13 under 35 U.S.C. § 103(a) as unpatentable over the *Nunan* article, taken with *Fujitani* '656, and further in view of *Suzuki, et al.*, US 6,335,305, is traversed and reconsideration is respectfully requested.

The combination of the *Nunan* article with the *Fujitani* '656 patent has already been discussed above, and the reasons apply here as well.

In the current invention the complete absence of alloy formation for the 1-layer Pd-Rh catalysts is shown from the X-ray diffraction patterns in Figures 7 and 8 and the absence of any performance penalties (especially for NO<sub>x</sub> conversion in Figures 2 – 6) when the 1-layer Pd-Rh technology is compared to 2-layer technologies where Pd and Rh are physically separated. Further, when RAT (Rapid Aging Test) agings are carried out that contain high temperature reducing/rich exhaust conditions that promote alloy formation between Pd and Rh, we further observe no performance penalties for the 1-layer Pd-Rh catalysts as shown in Figures 9 and 10. While the precise reason why alloy formation does not occur for the 1-layer Pd-Rh technology is not clear, applicant believes that it is related to the specific material types used in the wash coat

composition. Thus, claims 11 through 23 describe the characteristics of these wash coat materials in terms of their composition, morphological (porosity) and structural (cubic phase for the oxygen storage components) properties.

*Anatoly* '338 is acknowledged in the present application on page 12, para. [0046], and adds little if anything to the combination of prior art relied on in paragraph 6 on page 5 of the Official Action. Since the *Nunan* article fails to teach the non-alloyed condition of the precious metals as required by the claims, it is respectfully submitted that the combination cannot render the subject matter of Claims 11 and 12 *prima facie* obvious.

The *Suzuki* patent is relied on to show a catalyst for purification of the exhaust gases wherein an oxygen storage component having a cubic structure is present.

*Suzuki* shows a conventional catalyst material and even if the cubic structure of *Suzuki* were somehow incorporated into the combination resulting from *Nunan* taken with *Fujitani* '656, the final combination of teachings would still not arrive at applicants' invention as claimed in Claim 13.

Accordingly, applicants respectfully submit that the combination of *Nunan*, *Fujitani* '656, *Anatoly* '338 and *Suzuki* '305 fails to arrive at the present invention and does not create *prima facie* obviousness for the subject matter of Claims 11, 12 or 13.

Therefore, applicants respectfully request that the rejections be withdrawn.

The rejection of Claim 25 under 35 U.S.C. § 103(a) as unpatentable over the *Nunan* paper taken with *Fujitani* '656 and further taken with *Foster*, US 5,857,140, is traversed and reconsideration is respectfully requested.

The combination of the *Nunan* paper and *Fujitani* '656 has already been discussed above and the failings of that combination have been explained and the reasons set forth for traversing that rejection apply here as well.

*Foster* is relied on for the showing of a retention material in an exhaust gas treatment device.

Even if the retention material of *Foster* were added to the combination resulting from the teachings of *Nunan* and *Fujitani* '656, applicants respectfully submit that the combination of the three documents would not render the subject matter of Claim 25 *prima facie* obvious.

Accordingly, for reasons set forth above, applicants respectfully request that the rejection be withdrawn.

For the convenience of the Examiner, copies of the x-ray fracture patterns of a typical palladium-rhodium one-layer catalyst, prepared according to the invention where the palladium and rhodium are essentially non-alloyed is provided herewith.

Once again, it is emphasized that in the conventional type of catalyst formulations such as disclosed in the *Nunan* article of 1995, there is no teaching or suggestion of the benefits to be arrived at by having a one layer catalyst where the first and second catalyst are non-alloyed as established by the x-ray fracture patterns shown in Figures 7 and 8 of this application.

In summary, it is respectfully submitted that none of the references teach the essential feature of the present invention; namely, that beneficial results can be obtained in a one layer catalyst by adding the first and second metal in a non-alloyed condition.

For reasons set forth above, favorable action at the Examiner's earliest convenience is respectfully requested.

Respectfully submitted,

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